Airline/Manufacturer

MAINTENANCE PROGRAM DEVELOPMENT DOCUMENT

MSG-3

Revision 2

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September 1993

Prepared By:

Maintenance Steering Group - 3 Task Force
Air Transport Association of America

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AIRLINE/MANUFACTURER MAINTENANCE PROGRAM DEVELOPMENT DOCUMENT (MSG-3)

Mr. Michael F. Rioux
Vice President, Engineering,
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Air Transport Association of America
Washington, DC 20004-1707

Dear Mr. Rioux:

The Maintenance Review Board (MRB) Policy Board chairman has reviewed the Airline/Manufacturer Maintenance Program Development Document MSG-3, Revision 2, dated September 12, 1993. Minor discrepancies have been discussed with Mr. Dave Nakata.

The Federal Aviation Administration's Flight Standards Service, hereby, accepts MSG-3, Revision 2, dated September 12, 1993, as the guideline document for the development of future MRB reports.

Sincerely,

Frederick J. Leonelli
Manager, Aircraft Maintenance Division

MSG PREFACE

Airline and manufacturer experience in developing scheduled maintenance programs for new aircraft has shown that more efficient programs can be developed through the use of logical decision processes.

In July, 1968, representatives of various airlines developed Handbook MSG-1, "Maintenance Evaluation and Program Development," which included decision logic and inter-airline/manufacturer procedures for developing a maintenance program for the new Boeing 747 aircraft.

Subsequently, it was decided that experience gained on this project should be applied to update the decision logic and to delete certain 747 detailed procedural information so that a universal document could be made applicable for later new type aircraft. This was done and resulted in the document, entitled, "Airline/ Manufacturer Maintenance Program Planning Document," MSG-2. MSG-2 decision logic was used to develop scheduled maintenance programs for the aircraft of the 1970's.

In 1979, a decade after the publication of MSG-2, experience and events indicated that an update of MSG procedures was both timely and opportune in order for the document to be used to develop maintenance programs for new aircraft, systems or powerplants.

An ATA Task Force reviewed MSG-2 and identified various areas that were likely candidates for improvement. Some of these areas were the rigor of the decision logic, the clarity of the distinction between economics and safety, and the adequacy of treatment of hidden functional failures. Additionally:

A. The development of new generation aircraft provided a focus, as well as motivation, for an evolutionary advancement in the development of the MSG concept.

B. New regulations which had an effect on maintenance programs had been adopted and therefore needed to be reflected in MSG procedures. Among those were new damage tolerance rules for structures and the Supplemental Structural Inspection program for high time aircraft.

C. The high price of fuel and the increasing cost of materials created trade-off evaluations which had great influences on maintenance program development. As a result, maintenance programs required careful analysis to ensure that only those tasks were selected which provided genuine retention of the inherent designed level of safety and reliability, or provided economic benefit.

MSG-3, ORIGINAL REVISION: Against this background, ATA airlines decided that a revision to existing MSG-2 procedures was both timely and appropriate. The active participation and combined efforts of the FAA, CAA/UK, AEA, U.S. and European aircraft and engine manufacturers, U.S. and foreign airlines, and the U.S. Navy generated the document, MSG-3. As a result there were a number of differences between MSG-2 and MSG-3, which appeared both in the organization/presentation of the material and in the detailed procedural content. However, MSG-3 did not constitute a fundamental departure from the previous version, but was built upon the existing framework of MSG-2 which had been validated by ten years of reliable aircraft operation using maintenance programs based thereon.

The following reflects some of the major improvements and enhancements generated by MSG-3 as compared to MSG-2.

1. Systems/Powerplant Treatment:

   MSG-3 adjusted the decision logic flow paths to provide a more rational procedure for task definition and a more straightforward and linear progression through the decision logic.

   MSG-3 logic took a "from the top down" or consequence of failure approach. At the outset, the functional failure was assessed for consequence of failure and was assigned one of two basic categories:

   A. SAFETY
   B. ECONOMIC

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Further classification determined sub-categories based on whether the failure was evident to or hidden from the operating crew. (For structures, category designation was "significant" or "other" structure, and all functional failures were considered safety consequence items).

With the consequence category established for systems/powerplants, only those task selection questions pertinent to the category needed to be asked. This eliminated unnecessary assessments and expedited the analysis. A definite applicability and effectiveness criteria was developed to provide more rigorous selection of tasks. In addition, this approach helped to eliminate items from the analytical procedure whose failures had no significant consequence.

Task selection questions were arranged in a sequence such that the most preferred, most easily accomplished task, was considered first. In the absence of a positive indication concerning the applicability and effectiveness of a task, the next task in sequence was considered, down to and including possible redesign.

Structures Treatment:

Structures logic evolved into a form which more directly assessed the possibility of structural deterioration processes. Considerations of fatigue, corrosion, accidental damage, age exploration programs and others, were incorporated into the logic diagram and were routinely considered.

2. MSG-3 recognized the new damage tolerance rules and the supplemental inspection programs, and provided a method by which their intent could be adapted to the Maintenance Review Board (MRB) process instead of relying on type data certificate restraints. Concepts such as multiple failures, effect of failure on adjacent structure, crack growth from detectable to critical length, and threshold exploration for potential failure, were covered in the decision logic of the procedural material.

3. The MSG-3 logic was task-oriented and not maintenance process oriented (MSG-2). This eliminated the confusion associated with the various interpretations of Condition Monitoring (CM), On-Condition (OC), Hardtime (HT) and the difficulties encountered when attempting to determine what maintenance was being accomplished on an item that carried one of the process labels.

   By using the task-oriented concept, one would be able to view the MRB document and see the initial scheduled maintenance program reflected for a given item (e.g., an item might show a lubrication task at the "A" frequency, and inspection/functional check at the "C" frequency and a restoration task at the "D" frequency).

4. Servicing/Lubrication was included as part of the logic diagram to ensure that this important category of task was considered each time an item was analyzed.

5. The selection of maintenance tasks, as output from the decision logic, was enhanced by a clearer and more specific delineation of the task possibilities contained in the logic.

6. The logic provided a distinct separation between tasks applicable to either hidden or evident functional failures; therefore, treatment of hidden functional failures was more thorough than that of MSG-2.

7. The effect of concurrent or multiple failure was considered. Sequential failure concepts were used as part of the hidden functional failure assessment (Systems/Powerplant), and multiple failure was considered in structural evaluation (Structures).

8. There was a clear separation between tasks that were economically desirable and those that were required for safe operation.

9. The structures decision logic no longer contained a specific numerical rating system. The responsibility for developing rating systems was assigned to the appropriate manufacturer with approval of the Industry Steering Committee.

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<u>MSG-3, REVISION 1</u>: In 1987, after using MSG-3 procedures on a number of new aircraft and powerplants in the first half of the 1980's, it was decided that the benefits of the experience so gained should be used to improve the document for future application; thus, Revision 1 was undertaken.

This revised document includes changes developed by American and European airframe manufacturers, American and European airworthiness authorities, supplemented and agreed to by the Air Transport Association of America and other airline representatives.

The major improvements and enhancements reflected in items one through nine above were basically unchanged and remain applicable to this revised document.

The following are some of the more noteworthy revisions that have been incorporated:

1. Table of Contents and a List of Effective Pages: ADDED.
2. Clarification that MSG-3 is used to develop an "initial scheduled maintenance program."
3. The task - "Operating Crew Monitoring": DELETED.
4. Section addressing "Threshold Sample": REVISED.
5. Section addressing "Program Development Administration": DELETED.
6. "Top-down approach" - explanation of process: ADDED.
7. "Visual Check" added to "Operational Check" task.
8. System/Powerplant and Structures logic diagrams: REVISED.
9. Task selection criteria table: ADDED.
10. Inspections:
    - Detailed Inspection - REVISED.
    - Directed Inspection - DELETED.
    - External Surveillance Inspection - DELETED.
    - General Visual Inspection - REVISED.
    - Internal Surveillance Inspection - DELETED.
    - Special Detailed Inspection - UNCHANGED.
    - Walk Around Check Inspection - DELETED.
11. Clarification of hidden functional failure: "one additional failure."
12. Inspection/Functional Check task question revised.
13. Reference to a "User's Guide" for procedures related to administration and forms added.
14. Reference to "off-aircraft" deleted.
15. Operating Crew Normal Duties - "Normal Duties" revised to delete pre-flight and post-flight check list; added "on a daily basis" for frequency of usage with respect to normal crew duties.
16. Added that procedures for handling composite of other new materials may have to be developed.
17. Reference to specific U.S. Federal Air Regulations: DELETED.
18. Definition of "Operating": REVISED.
19. Defined logic for failures which may affect dispatch capability or involve the use of abnormal or emergency procedures. Failure-effect Category 6 is now identified as "Operational - Evident".
20. Noted that each MSI and SSI should be recorded for tracking purposes whether or not a task was derived therefrom.

<u>MSG-3, Revision 2</u>: In 1993, MSG-3 Revision 2 was incorporated. The most significant changes introduced were:

1. To adapt MSG-3 logic procedures to assure development of tasks/intervals associated with the aircraft's certificated operating capabilities.

2. To provide guidelines which ensure that a consistent approach be taken with respect to tasks/intervals required to maintain compliance with Type Certification requirements.

3. To provide guidelines on the development of Corrosion Prevention and Control Programs.

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4. To introduce procedures to determine the appropriate scheduled maintenance requirements for composite structure.

5. To revise inspection task definitions.

MSG-3 Section 2.4 and its respective logic diagrams have been revised to add an evaluation process to insure the Corrosion Prevention and Control Program (CPCP) is considered in the evaluation of each Structural Significant Item (SSI) and every zone.

Damage Sources Section 2.4.3.1 now includes a discussion of non-metallic materials (composites).

Procedures Section 2.4.4.1 has been revised to add Procedure and Decision blocks for the CPCP evaluation and edited to produce a more ordered flow of the Procedure and Decision block numbers.

The Glossary - Appendix A Inspection Level Definitions have been revised to apply to Systems, Powerplants and Structures, and definitions related to CPCP have been added.

It is suggested, in order to fully comprehend the MSG-3 concept, that the entire MSG-3 document be reviewed and considered prior to accepting or modifying its approaches to maintenance programs development. A User's Guide or Policies and Procedures Handbook may be adopted with guidance and approval of the Industry Steering Committee.

1. GENERAL

1.1 OBJECTIVE

It is the objective of this document to present a means for developing a maintenance program which will be acceptable to the regulatory authorities, the operators, and the manufacturers. The maintenance program details will be developed by coordination with specialists from the operators, manufacturers, and the Regulatory Authority of the country of manufacture. Specifically, this document outlines the general organization and decision processes for determining scheduled maintenance requirements initially projected for the life of the aircraft and/or powerplant.

Historically, the initial scheduled maintenance program has been specified in Maintenance Review Board (MRB) Reports. MSG-3 is intended to facilitate the development of initial scheduled maintenance programs. The remaining maintenance, that is, non-scheduled or non-routine maintenance, consists of maintenance actions to correct discrepancies noted during scheduled maintenance tasks, other non-scheduled maintenance, normal operation, or data analysis.

This document addresses the development of a maintenance program using the MSG-3 analysis procedure. Any additional requirements developed, using different ground rules and procedures from MSG-3, must be submitted with selection criteria to the Industry Steering Committee for consideration and inclusion in the MRB Report recommendation.

1.2 SCOPE

For the purpose of developing an MRB report, MSG-3 is to be used to determine initial scheduled maintenance requirements. The analysis process identifies all scheduled tasks and intervals based on the aircraft's certificated operating capabilities.

1.3 ORGANIZATION

The organization to carry out the maintenance program development for a specific type aircraft shall be staffed by representatives of the airline operators purchasing the equipment, the prime manufacturers of the airframe and powerplant, and the Regulatory Authority.

1.3.1 Industry Steering Committee

The management of the maintenance program development activities shall be accomplished by an Industry Steering Committee composed of members from a representative number of operators and representatives of the prime airframe and engine manufacturers. It shall be the responsibility of this committee to establish policy, set initial goals for scheduled maintenance check intervals, direct the activities of Working Groups or other working activity, carry out liaison with the manufacturer and other operators, prepare the final program recommendations and represent the operators in contacts with the Regulatory Authority. The ISC should see that the MSG-3 process identifies 100% accountability for all Maintenance Significant Items (MSI's) and Structural Significant Items (SSI's), whether or not a task has been derived from the analysis.

1.3.2 Working Groups

One or more Working Groups, consisting of specialist representatives from the participating operators, the prime manufacturer, and the Regulatory Authority, may be constituted. The Industry Steering Committee, alternatively, may arrange some other means for obtaining the detailed technical information necessary to develop recommendations for maintenance programs in each area. Irrespective of the organization of the working activity, written technical data must be provided that supports its recommendations to the Industry Steering Committee. After approval by the Industry Steering Committee, these analyses and recommendations shall be consolidated into a final report for presentation to the Regulatory Authority.

2. DEVELOPMENT OF MAINTENANCE PROGRAMS

2.1 PROGRAM REQUIREMENTS

It is necessary to develop a maintenance program for each new type of aircraft prior to its introduction into airline service.

2.1.1 Purpose

The primary purpose of this document is to develop a proposal to assist the Regulatory Authority in establishing an initial scheduled maintenance program for new types of aircraft and/or powerplant. The intent of this program is to maintain the inherent safety and reliability levels of the equipment. This program becomes the basis for the first issue of each airline's maintenance requirements to govern its initial maintenance policy. Initial adjustments may be necessary to address operational and/or environmental conditions unique to the operator. As operating experience is accumulated, additional adjustments may be made by the operator to maintain an efficient maintenance program.

2.1.2 Approach

It is desirable, therefore, to define in some detail:

a) The objectives of an efficient maintenance program.

b) The content of an efficient maintenance program.

c) The method by which an efficient maintenance program can be developed.

2.1.2.1 Maintenance Program Objectives

The objectives of an efficient airline maintenance program are:

a) To ensure realization of the inherent safety and reliability levels of the equipment.

b) To restore safety and reliability to their inherent levels when deterioration has occurred.

c) To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate.

d) To accomplish these goals at a minimum total cost, including maintenance costs and the costs of resulting failures.

These objectives recognize that maintenance programs, as such, cannot correct deficiencies in the inherent safety and reliability levels of the equipment. The maintenance program can only prevent deterioration of such inherent levels. If the inherent levels are found to be unsatisfactory, design modification is necessary to obtain improvement.

2.1.2.2 Maintenance Program Content

The content of the maintenance program itself consists of two groups of tasks:

a) A group of scheduled tasks to be accomplished at specified intervals. The objective of these tasks is to prevent deterioration of the inherent safety and reliability levels of the equipment. The tasks in a scheduled maintenance program may include:

(1)	Lubrication/Servicing	(LU/SV)
(2)	Operational/Visual Check	(OP/VC)
(3)	Inspection/Functional Check	(IN/FC)
(4)	Restoration	(RS)
(5)	Discard	(DS)

and

b) A group of non-scheduled tasks which result from:

(1) The scheduled tasks accomplished at specified intervals.
(2) Reports of malfunctions (usually originated by the operating crew).
(3) Data analysis.

The objective of these non-scheduled tasks is to restore the equipment to an acceptable condition.

An efficient program is one which schedules only those tasks necessary to meet the stated objectives. It does not schedule additional tasks which will increase maintenance costs without a corresponding increase in reliability protection.

2.1.2.3 Method for Maintenance Program Development

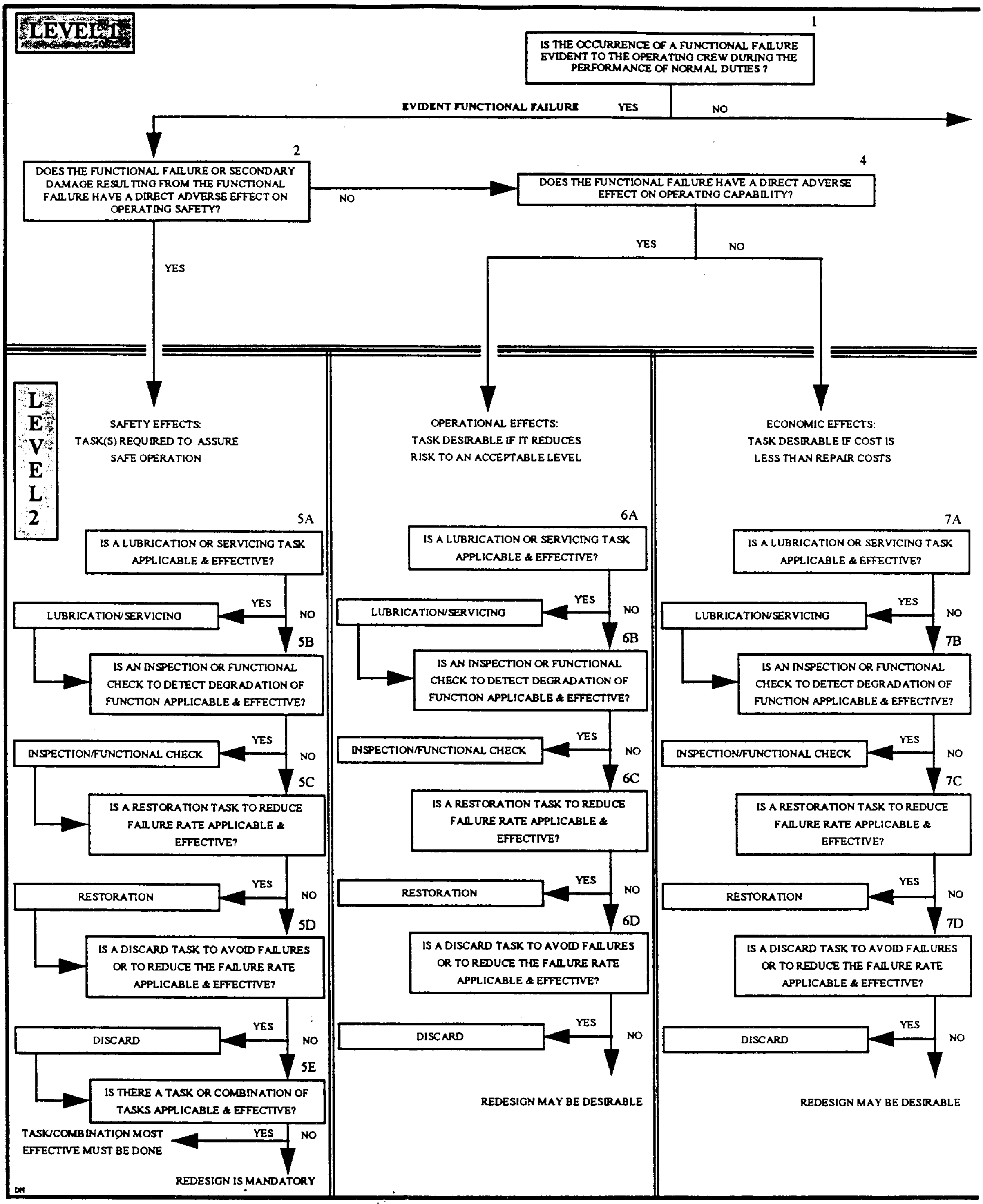
This document describes the method for developing the scheduled maintenance program. Non-scheduled maintenance results from scheduled tasks, normal operation or data analysis.

Maintenance programs will be developed via use of a guided logic approach and will result in a task-oriented program. The logic's flow of analysis is failure-effect oriented.

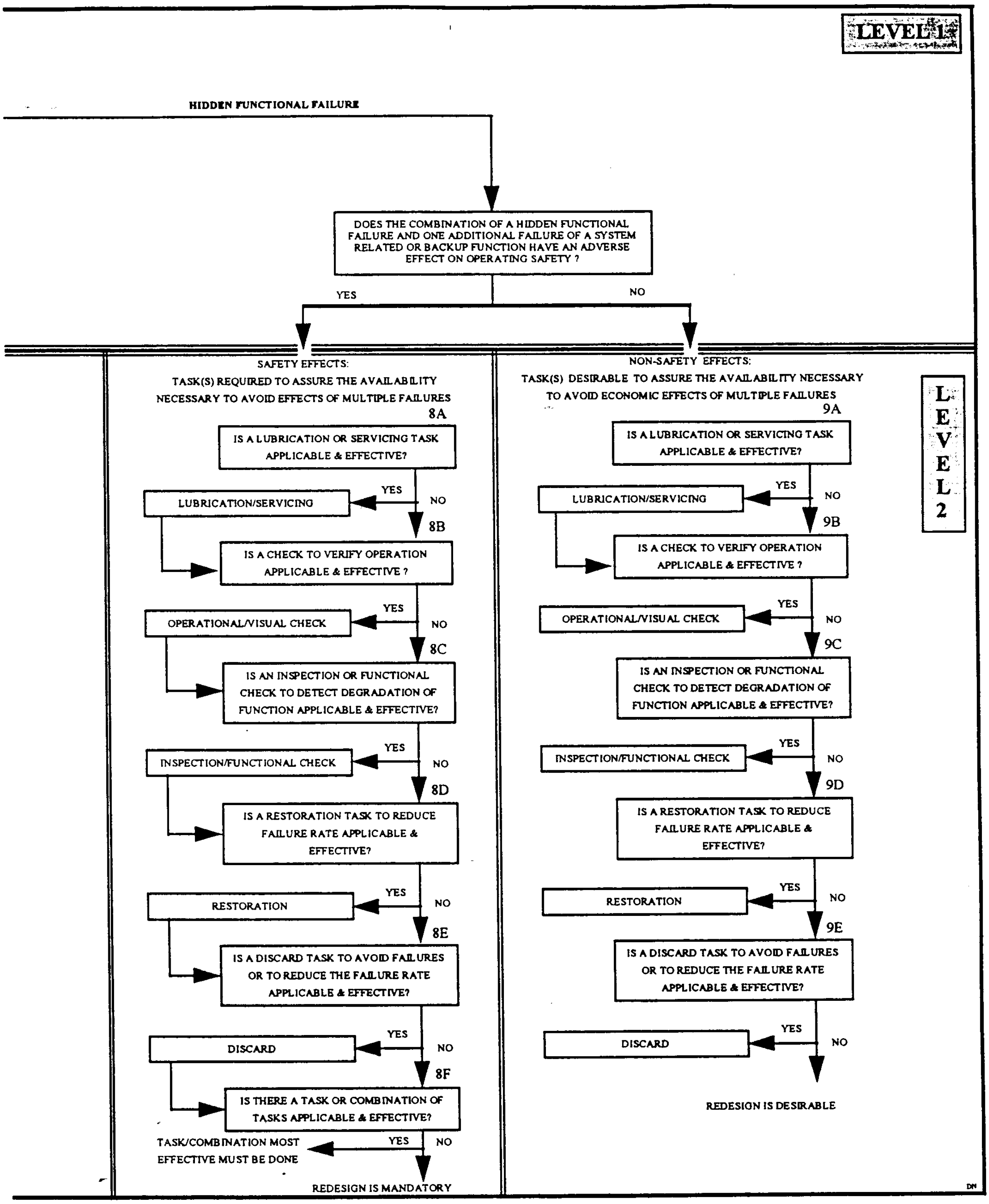
Items that, after analysis, have no scheduled task(s) specified, may be monitored by an operator's reliability program.

2.2 DIVISIONS OF MSG-3 DOCUMENT

The working portions of MSG-3 are contained in the next three sections. Systems/Powerplant, including components and APU's, are considered in Section 2.3. Aircraft Structures is considered in Section 2.4, and Zonal Inspections in Section 2.5. Each section contains its own explanatory material and decision logic diagram (as appropriate); therefore, it may be used independently of other MSG-3 sections.



SYSTEMS/POWERPLANT
LOGIC DIAGRAM
FIGURE 1



SYSTEMS/POWERPLANT
LOGIC DIAGRAM
FIGURE 1 (CONT'D.)

2.3 AIRCRAFT SYSTEMS/POWERPLANT ANALYSIS METHOD

The method for determining the maintenance program for systems/powerplant, including components and APU's, uses a progressive logic diagram. A glossary of terms and definitions used in the logic diagram is listed in Appendix A. This logic is the basis of an evaluation technique applied to each maintenance significant item (system, sub-system, module, component, accessory, unit, part, etc.), using the technical data available. Principally, the evaluations are based on the item's functional failures and failure causes.

Before the actual MSG-3 logic can be applied to an item, the aircraft's significant systems and components must be identified. This process of identifying Maintenance Significant Items (MSI's) is a conservative process (using engineering judgment) based on the anticipated consequences of failure.

MSI's are those items identified by the manufacturer whose failure:

a) could affect safety (on ground or in flight), and/or,

b) could be undetectable or are not likely to be detected during operations, and/or,

c) could have significant operational impact, and/or,

d) could have significant economic impact.

The initial list of MSI's is prepared by the manufacturer and submitted to the ISC for distribution to the appropriate Working Groups.

The top-down approach is a system of identifying the significant items on the aircraft. An acceptable process follows:

a) Partition the aircraft into major functional areas: ATA Systems and Sub-Systems.

b) Continue the process until sub-components which are not replaced on-aircraft are identified.

c) A candidate MSI is usually a system or sub-system and is, in most cases, one level above the lowest (on-aircraft) level identified in step "b." This level is considered the highest manageable level, i.e., one which is high enough to avoid unnecessary analysis, but low enough to be properly analyzed and ensure that all functions, failures, and causes are covered.

After the MSI's have been selected, the following must be identified for each MSI:

a) Functions(s) - the normal characteristic actions of an item

b) Functional Failure(s) - how an item fails to perform its function

c) Failure Effect(s) - what is the result of a functional failure

d) Failure Cause(s) - why the functional failure occurs

Tasks and intervals required in the maintenance program are identified using the procedures set forth herein. Both the economic and safety related tasks are included so as to produce an initial scheduled maintenance program.

2.3.1 Task Analysis Procedure

Prior to applying the MSG-3 logic diagram to an item, a preliminary work sheet will be completed that clearly defines the MSI, its function(s), functional failure(s), failure effect(s), failure cause(s) and any additional data pertinent to the item; e.g., ATA chapter reference, fleet applicability, manufacturer's part number, a brief description of the item, expected failure rate, hidden functions, need to be on M.E.L., redundancy (may be unit, system or system management), etc. This work sheet is to be designed to meet the user's requirements and will be included as part of the total MSG-3 documentation for the item.

2.3.1 Task Analysis Procedure (cont'd.)

The approach taken in the following procedure is to provide a logic path for each functional failure. Each functional failure and failure cause must be processed through the logic so that a judgment will be made as to the necessity of a task. The resultant tasks and intervals will form the initial scheduled maintenance program.

2.3.2 Logic Diagram

The decision logic diagram (see figure 1) is used for analysis of systems/powerplant items. The logic flow is designed whereby the user begins the analysis at the top of the diagram, and answers to the "YES" or "NO" questions will dictate direction of the analysis flow.

2.3.2.1 Levels of Analysis

The decision logic has two levels (see Figure 1):

a) Level 1 (questions 1, 2, 3 and 4) requires the evaluation of each FUNCTIONAL FAILURE for determination of the Failure Effect Category; i.e., safety, operational, economic, hidden safety or hidden non-safety.

b) Level 2 (questions 5,6,7,8 and 9, "A" through "F", as applicable) then takes the FAILURE CAUSE(S) for each functional failure into account for selecting the specific type of task(s).

At level 2, the task selection section, paralleling and default logic have been introduced. Regardless of the answer to the first question regarding "Lubrication/Servicing", the next task selection question must be asked in all cases. When following the hidden or evident safety effects path, all subsequent questions must be asked. In the remaining categories, subsequent to the first question, a "YES" answer will allow exiting the logic.

NOTE: At the user's option, advancement to subsequent questions after deriving a "YES" answer is allowable, but only until the cost of the task is equal to the cost of the failure prevented.

Default logic is reflected in paths outside the safety effects areas by the arrangement of the task selection logic. In the absence of adequate information to answer "YES" or "NO" to questions in the second level, default logic dictates a "NO" answer be given and the subsequent question be asked. As "NO" answers are generated the only choice available is the next question, which in most cases provides a more conservative, stringent and/or costly task.

2.3.3 Procedure

This procedure requires consideration of the functional failures, failure causes, and the applicability/ effectiveness of each task. Each functional failure processed through the logic will be directed into one of five Effect categories.

2.3.4 Consequences of Failure (First Level)

The decision logic diagram (see Figure 1) facilitates the identification of the tasks required. There are four first level questions.

2.3.4.1 Evident or Hidden Functional Failure

Question 1:

IS THE OCCURRENCE OF A FUNCTIONAL FAILURE EVIDENT TO THE OPERATING CREW DURING THE PERFORMANCE OF NORMAL DUTIES?

This question asks if the operating crew will be aware of the loss (failure) of the function during performance of normal operating duties. Question 1 must be asked for each functional failure of the item being analyzed. The intent is to segregate the evident and hidden functional failures. The operating crew consists of qualified cockpit and cabin attendant personnel who are on duty. Normal duties are those duties associated with the routine operation of the aircraft on a daily basis.

A "YES" answer indicates the functional failure is evident; proceed to Question 2 (2.3.4.2).

A "NO" answer indicates the functional failure is hidden; proceed to Question 3 (2.3.4.3).

2.3.4.2 Direct Adverse Effect on Safety

Question 2:

DOES THE FUNCTIONAL FAILURE OR SECONDARY DAMAGE RESULTING FROM THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING SAFETY?

For a "YES" answer the functional failure must have a direct adverse effect on operating safety.

Direct: To be direct the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).

Adverse Effect on Safety: This implies that the consequences are extremely serious or possibly catastrophic and might cause the loss of aircraft or injury to occupants.

Operating: This is defined as the time interval during which passengers and crew are on board for the purpose of flight.

A "YES" answer indicates that this functional failure must be treated within the Safety Effects category and task(s) must be developed in accordance with section 2.3.5.1.

A "NO" answer indicates the effect is either operational or economic and Question 4 (2.3.4.4) must be asked.

2.3.4.3 Hidden Functional Failure Safety Effect

Question 3:

DOES THE COMBINATION OF A HIDDEN FUNCTIONAL FAILURE AND ONE ADDITIONAL FAILURE OF A SYSTEM RELATED OR BACK-UP FUNCTION HAVE AN ADVERSE EFFECT ON OPERATING SAFETY?

This question is asked of each hidden functional failure which has been identified in Question 1.

The question takes into account failures in which the loss of the one hidden function (whose failure is unknown to the operating crew) does not of itself affect safety; however, in combination with an additional functional failure (system related or intended to serve as a back-up) has an adverse effect on operating safety.

For protective safety/emergency systems or equipment, the additional failure is the event for which the system or equipment is designed.

If a "YES" answer is determined, there is a safety effect and task development must proceed in accordance with 2.3.5.4.

A "NO" answer indicates that there is a non-safety effect and will be handled in accordance with 2.3.5.5.

2.3.4.4 Operational Effect

Question 4:

DOES THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING CAPABILITY?

This question asks if the functional failure could have an adverse effect on operating capability:

a) requiring either the imposition of operating restrictions or correction prior to further dispatch; or

b) requiring flight crew use of abnormal or emergency procedures.

This question is asked of each evident functional failure not having a direct adverse effect on safety. The answer may depend on the type of operation.

If the answer to this question is "YES", the effect of the functional failure has an adverse effect on operating capability, and task selection will be handled in accordance with 2.3.5.2.

A "NO" answer indicates that there is an economic effect and should be handled in accordance with 2.3.5.3.

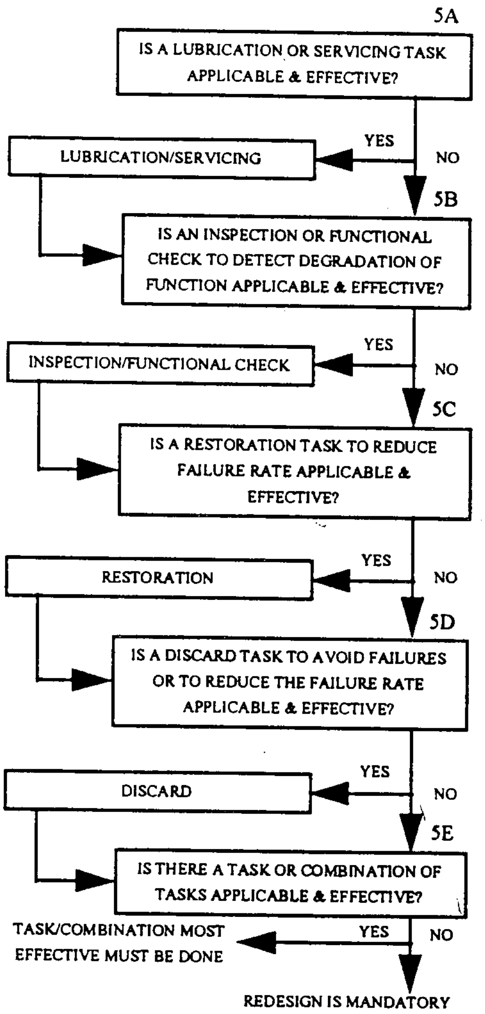
2.3.5 Failure Effect Categories (First Level)

Once the analysts have answered the applicable first level questions, they are directed to one of the five Effect Categories:

a) Evident Safety (5),
b) Evident Operational (6),
c) Evident Economic (7),
d) Hidden Safety (8),
e) Hidden Non-Safety (9).

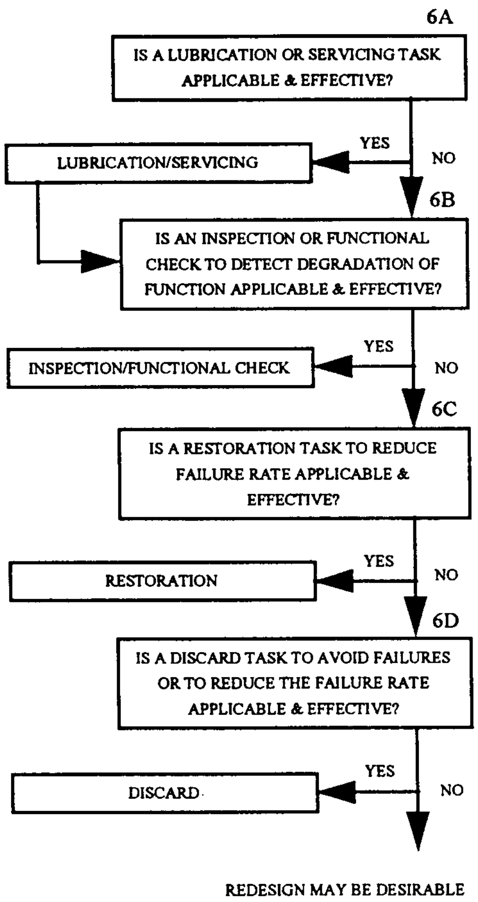
2.3.5.1 Evident Safety Effects (category 5)

The Evident Safety Effect category must be approached with the understanding that a task is required to assure safe operation. All questions in this category must be asked. If no effective task(s) results from this category analysis, then redesign is mandatory. The following is the logic progression for functional failures that have Evident Safety Effects.



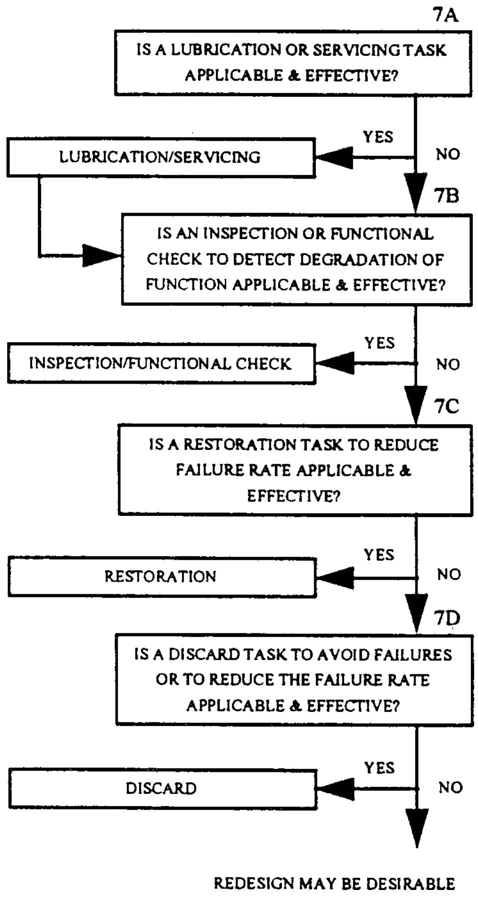
2.3.5.2 Evident Operational Effects (category 6)

A task(s) is desirable if it reduces the risk of failure to an acceptable level. Analysis of the failure causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer of question "A" still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", then no task has been generated. In such a case, the appropriate item is forwarded to the Industry Steering Committee for review with the MRB. If operational penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Evident Operational Effects.



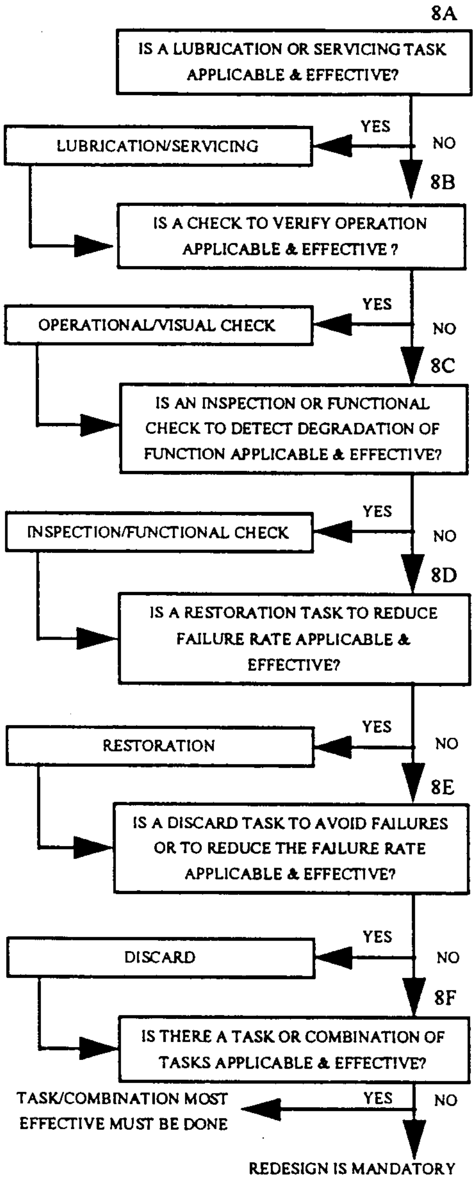
2.3.5.3 <u>Evident Economic Effects</u> (category 7)

A task(s) is desirable if the cost of the task is less than the cost of repair. Analysis of the failure causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer to question "A" still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant task(s) will satisfy the requirements. If all answers are "NO", no task has been generated. If economic penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Evident Economic Effects.



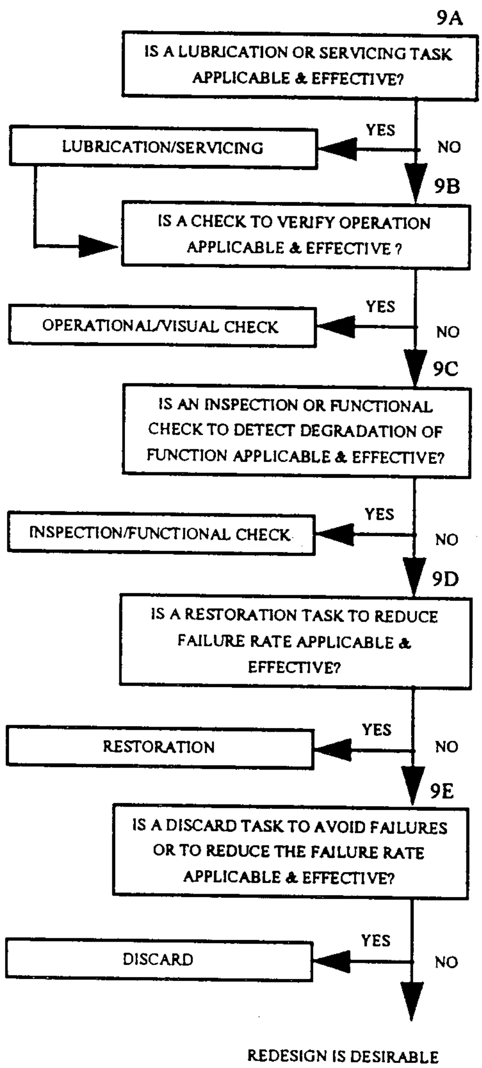
2.3.5.4 Hidden Function Safety Effects (category 8)

The Hidden Function Safety Effect requires a task(s) to assure the availability necessary to avoid the safety effect of multiple failures. All questions must be asked. If there are no tasks found effective, then redesign is mandatory. The following is the logic progression for functional failures that have Hidden Function Safety Effects.



2.3.5.5 Hidden Function Non-Safety Effects (category 9)

The Hidden Function Non-Safety Effect category indicates that a task(s) may be desirable to assure the availability necessary to avoid the economic effects of multiple failures. Movement of the failure causes through the logic requires the first question (Lubrication/Servicing) to be answered. Either a "YES" or "NO" answer still requires movement to the next level; from this point on, a "YES" answer will complete the analysis and the resultant tasks(s) will satisfy the requirements. If all answers are "NO", no task has been generated. If economic penalties are severe, a redesign may be desirable. The following is the logic progression for functional failures that have Hidden Function Non-Safety Effects.



2.3.6 Task Development (Second Level)

Task development is handled in a similar manner for each of the five Effect categories. For task determination, it is necessary to apply the failure causes for the functional failure to the second level of the logic diagram. There are six possible task resultant questions in the Effect categories as follows:

2.3.6.1 Lubrication/Servicing (ALL CATEGORIES)

IS A LUBRICATION OR SERVICING TASK APPLICABLE AND EFFECTIVE?

Any act of lubrication or servicing for the purpose of maintaining inherent design capabilities.

Applicability Criteria:

The replenishment of the consumable must reduce the rate of functional deterioration.

Effectiveness Criteria - Safety:

The task must reduce the risk of failure.

Effectiveness Criteria - Operational:

The task must reduce the risk of failure to an acceptable level.

Effectiveness Criteria - Economic:

The task must be cost-effective.

2.3.6.2 Operational/Visual Check (HIDDEN FUNCTIONAL FAILURE CATEGORIES ONLY)

IS A CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE?

An operational check is a task to determine that an item is fulfilling its intended purpose. The check does not require quantitative tolerances. This is a failure finding task.

A visual check is an observation to determine that an item is fulfilling its intended purpose. The check does not require quantitative tolerances. This is a failure finding task.

Applicability Criteria:

Identification of failure must be possible.

Effectiveness Criteria - Safety:

The task must ensure adequate availability of the hidden function to reduce the risk of a multiple failure.

Effectiveness Criteria - Economic:

The task must ensure adequate availability of the hidden function in order to avoid economic effects of multiple failures and must be cost-effective.

2.3.6.3 Inspection/Functional Check (ALL CATEGORIES)

IS A INSPECTION OR FUNCTIONAL CHECK TO DETECT DEGRADATION OF FUNCTION APPLICABLE AND EFFECTIVE?

An inspection is:

A. DETAILED INSPECTION

An intensive visual examination of a specific structural area, system, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate by the inspector. Inspection aids such as mirrors, magnifying lenses, etc. may be used. Surface cleaning and elaborate access procedures may be required.

OR

B. GENERAL VISUAL (SURVEILLANCE) INSPECTION

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

OR

C. SPECIAL DETAILED INSPECTION

An intensive examination of a specific item(s), installation, or assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized Inspection Techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required.

A functional check is a quantitative check to determine if one or more functions of an item performs within specified limits.

Applicability Criteria:

Reduced resistance to failure must be detectable, and there exists a reasonably consistent interval between a deterioration condition and functional failure.

Effectiveness Criteria - Safety:

The task must reduce the risk of failure to assure safe operation.

Effectiveness Criteria - Operational:

The task must reduce the risk of failure to an acceptable level.

Effectiveness Criteria - Economic:

The task must be cost-effective; i.e., the cost of the task must be less than the cost of the failure prevented.

2.3.6.4 Restoration (ALL CATEGORIES)

IS A RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?

That work necessary to return the item to a specific standard.

Since restoration may vary from cleaning or replacement of single parts up to a complete overhaul, the scope of each assigned restoration task has to be specified.

Applicability criteria:

The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age. It must be possible to restore the item to a specific standard of failure resistance.

Effectiveness Criteria - Safety:

The task must reduce the risk of failure to assure safe operation.

Effectiveness Criteria - Operational:

The task must reduce the risk of failure to an acceptable level.

Effectiveness Criteria - Economic:

The task must be cost-effective: i.e., the cost of the task must be less than the cost of the failure prevented.

2.3.6.5 Discard (ALL CATEGORIES)

IS A DISCARD TASK TO AVOID FAILURES OR TO REDUCE THE FAILURE RATE APPLICABLE AND EFFECTIVE?

The removal from service of an item at a specified life limit.

Discard tasks are normally applied to so-called single celled parts such as cartridges, canisters, cylinders, engine disks, safe-life structural members, etc.

Applicability Criteria:

The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age.

Effectiveness Criteria - Safety:

A safe-life limit must reduce the risk of failure to assure safe operation.

Effectiveness Criteria - Operational:

The task must reduce the risk of failure to an acceptable level.

Effectiveness Criteria - Economic:

An economic-life limit must be cost-effective: i.e., the cost of the task must be less than the cost of the failure prevented.

2.3.6.6 Combination (SAFETY CATEGORIES ONLY)

IS THERE A TASK OR COMBINATION OF TASKS APPLICABLE AND EFFECTIVE?

Since this is a safety category question and a task is required, all possible avenues must be analyzed. To do this, a review of the task(s) that are applicable is necessary. From this review the most effective task(s) must be selected.

2.3.6.7 Task Selection Criteria

TASK	APPLICABILITY	SAFETY EFFECTIVENESS	OPERATIONAL EFFECTIVENESS	ECONOMIC EFFECTIVENESS
LUBRICATION OR SERVICING	The replenishment of the consumable must reduce the rate of functional deterioration.	The task must reduce the risk of failure.	The task must reduce the risk of failure to an acceptable level.	The task must be cost effective.
OPERATIONAL OR VISUAL CHECK	Identification of failure must be possible.	The task must ensure adequate availability of the hidden function to reduce the risk of a multiple failure.	Not applicable.	The task must ensure adequate availability of the hidden function in order to avoid economic effects of multiple failures and must be cost effective.
INSPECTION OR FUNCTIONAL CHECK	Reduce resistance to failure must be detectable, and there exists a reasonably consistent interval between a deterioration condition and functional failure.	The task must reduce the risk of failure to assure safe operation.	The task must reduce the risk of failure to an acceptable level.	The task must be cost effective; *i.e.*, the cost of the task must be less than the cost of the failure prevented.
RESTORATION	The item must show functional degradation characteristics at an identifiable age, and a large proportion of units must survive to that age. It must be possible to restore the item to a specific standard of failure resistance.	The task must reduce the risk of failure to assure safe operation.	The task must reduce the risk of failure to an acceptable level.	The task must be cost effective; *i.e.*, the cost of the task must be less than the cost of the failure prevented.
DISCARD	The item must show functional degradation characteristics at an identifiable age and a large proportion of units must survive to that age.	The safe life limit must reduce the risk of failure to assure safe operation.	The task must reduce the risk of failure to an acceptable level.	An economic life limit must be cost effective; *i.e.*, the cost of the task must be less than the cost of the failure prevented.

2.3.7 Setting Task Frequencies/Intervals

Determine whether real and applicable data are available which suggest an effective interval for task accomplishment. Appropriate information may consist of one or more of the following:

a) Prior knowledge from other aircraft systems/power-plants that show a scheduled maintenance task has offered substantial evidence of being effective and economically worthwhile.

b) Manufacturer's test data which indicates that a scheduled maintenance task will be effective for the item being evaluated.

c) If there is no prior knowledge from other aircraft systems/powerplant, or if there is insufficient similarity between the previous and current systems, the task interval/frequency can only be established initially by experienced working group and steering committee personnel using good judgment and operating experience in concert with accurate data (reliability, redundancy, dispatch, etc.).

2.3.7.1 Threshold Sample

The threshold sample is an examination of a specified number of items in order to verify design calculations while attaining in-service experience with the items. Thresholds may be established for the MRB defined items.

2.4 AIRCRAFT STRUCTURAL MAINTENANCE PROGRAM DEVELOPMENT

This section contains guidelines for developing scheduled maintenance tasks for aircraft structure. These are designed to relate the scheduled maintenance tasks to the consequences of structural damage remaining undetected. Each structural item is assessed in terms of its significance to continuing airworthiness, susceptibility to any form of damage, and the degree of difficulty involved in detecting such damage. Once this is established, a structural maintenance program can be developed which can be shown to be effective in detecting and preventing structural degradation due to fatigue, environmental deterioration, or accidental damage throughout the operational life of the aircraft. The structural maintenance task(s) developed as part of the structural maintenance program are used to satisfy aircraft type certification and MRB requirements.

Mandatory replacement times for structural safe-life parts are included in the Airworthiness Limitations, required by the regulatory authorities as part of the Instructions for Continued Airworthiness. Some of the items requiring fatigue related inspections may also be included, as well as specific Corrosion Prevention and Control Program (CPCP) tasks which subsequently warrant inclusion, based on the in-service experience of the operators.

Requirements for detecting Accidental Damage (AD), Environmental Deterioration (ED), Fatigue Damage (FD), and procedures for preventing and/or controlling corrosion form the basis for the MRB structural maintenance program. However, all FD inspection requirements may not be available when the aircraft enters service. In such cases the manufacturer shall propose, prior to the entry of the aircraft into service, an appropriate time frame for completing the FD inspection requirements.

Procedures should be developed for composite or other new materials because damage characteristics may not follow those accepted for metallic structures.

2.4.1 Structural Maintenance Program Requirements

The primary objective of a structural maintenance program is to maintain the inherent airworthiness throughout the operational life of the aircraft in an economical manner. To achieve this, the inspections in this program must meet the detection requirements from each of the AD, ED and FD assessments. Full account may be taken of all applicable inspections occurring in the fleet.

Inspections related to detection of AD/ED are applicable to all aircraft when they first enter service. Changes or adjustments can be made to these inspections based on individual operator experience, when approved by their local regulatory authority.

Additional maintenance tasks (related to the ED Program) to control corrosion to Level 1 or better are applicable at a threshold which is established during the aircraft type certification process. These are based on manufacturer and operator experience with similar aircraft structure, taking into consideration differences in relevant design features e.g. choice of material, assembly process, corrosion protection systems, galley and toilet design etc. See also Section 2.4.1.5 entitled Corrosion Prevention and Control Program.

Inspections related to FD detection are applicable after a threshold, which is established during the aircraft type certification process. At the time the fatigue related inspections are implemented, a sampling program can be used, where such a program is applicable and effective. The fatigue related inspections are based directly on the manufacturer's approved damage tolerance evaluations and changes or adjustments by the operators require use of an approved procedure.

Where no service experience exists with similar structure, the structural maintenance requirements shall be based on manufacturer's recommendations.

Proposed initial scheduled maintenance checks, to be used as the basis for the structural maintenance program, are established for each aircraft type by the Industry Steering Committee on the basis of:

2.4.1 Structural Maintenance Program Requirements (cont'd.)

a. Operator experience

b. Manufacturer's proposals

c. Considerations of systems analysis requirements

2.4.1.1 Structural Maintenance Tasks

As part of the structural maintenance program development procedure, applicable and effective structural maintenance tasks are selected for each deterioration process of the SSI. To assure a direct correlation between the structural damage tolerance evaluations and the structural maintenance program, it is necessary to describe each task.

To all extents possible, the inspection methods specified in the tasks should use the standard set of definitions included in the MSG-3 glossary. Changes and/or additions to the inspection methods and definitions must be approved by the Industry Steering Committee.

2.4.1.2 Inspection Thresholds

The inspection threshold for each SSI inspection task is a function of the source of damage as follows:

a. Accidental Damage -
The first inspection (threshold) for accidental damage normally corresponds to a period equal to the defined repeat inspection interval, from the time of first entry into service.

b. Environmental Deterioration -
The initial inspection thresholds for all levels of inspection are based on existing relevant service experience, manufacturers recommendations, and/or a conservative age exploration program.

c. Fatigue Damage -
Inspections directly related to fatigue damage detection will occur after a threshold(s) to be established by the manufacturer and approved by the appropriate regulatory authority Thresholds are normally established as part of the damage tolerance certification requirements. These are subject to change as service experience, additional testing, or analysis work is obtained.

2.4.1.3 Repeat Inspection Intervals

After each inspection has been conducted, the repeat interval sets the period until the next inspection.

a. Accidental Damage -
The repeat interval should be based on operator and manufacturer experience with similar structure. Selected intervals will normally correspond to single or multiple levels of the scheduled maintenance check intervals.

b. Environmental Deterioration -
The repeat interval for detection/prevention/control of ED (corrosion, stress corrosion, etc.) should be based on existing relevant service experience and/or manufacturers recommendations.

2.4.1.3 Repeat Inspection Intervals (cont'd.)

c. Fatigue Damage - The repeat intervals for fatigue related inspections are based on the damage tolerance evaluations. These are used to demonstrate that applicable and effective inspections provide sufficient probability of detecting fatigue damage for each SSI.

2.4.1.4 Fatigue Related Sampling Inspection Programs

Transport aircraft with the highest number of flight cycles are most susceptible to initial fatigue cracking in the fleet. This means that adequate inspections on such aircraft will provide the greatest benefits for timely detection of fatigue damage. Such sampling inspection programs are developed on the basis of appropriate statistical variables, including:

a. The number of aircraft inspected.
b. The inspection methods and repeat intervals.
c. The number of flight cycles completed.

A list of SSIs that are suitable for a fatigue related sampling inspection program(s) will be established by the Structures Working Group and submitted to the Industry Steering Committee for approval and inclusion in the MRB report proposal. Full details of the fatigue related sampling inspection program(s) will be established by a joint operator/ manufacturer task force, based on the manufacturer's technical evaluations, prior to aircraft exceeding the fatigue damage threshold(s).

2.4.1.5 Corrosion Prevention and Control Programs (CPCP)

A Corrosion Prevention and Control Program should be established to maintain the aircraft's resistance to corrosion as a result of systematic (e.g. age related) deterioration through chemical and/or environmental interaction.

The program is expected to allow control of the corrosion on the aircraft to Corrosion Level 1 or better. The CPCP should be based on the ED analysis, assuming an aircraft operated in a typical environment. If corrosion is found to exceed Level 1 at any inspection time, the corrosion control program for the affected area must be reviewed by the operator with the objective to ensure Corrosion Level 1 or better.

2.4.1.6 Age Exploration Programs

An age exploration program may be desirable to verify the aircraft's resistance to corrosion deterioration before the Corrosion Prevention and Control Program Task Thresholds.

Guidelines for age exploration programs should be established by the Structures Working Group and submitted to the Industry Steering Committee for approval and inclusion in the structural maintenance program.

2.4.1.7 Zonal Inspections

Some parts of the inspection requirements for SSIs and most of the items categorized as Other Structure can be provided by the zonal program (see Section 2.5).

Tasks and intervals included in the zonal program should be based on operator and manufacturer experience with similar structure. For structure containing new materials and/or construction concepts, tasks and intervals may be established based on assessment of the manufacturer's recommendations.

2.4.1.8 Inspection Results

The type certificate holder (manufacturer) and the operators will implement a satisfactory system for the effective collection and dissemination of service experience from the structural maintenance program.

This process will supplement the system which is required by existing regulations for reporting occurrences of failures, malfunctions or defects (e.g. Service Difficulty Reports).

2.4.2 Aircraft Structure Defined

Aircraft structure consists of all load carrying members including wings, fuselage, empennage, engine mountings, landing gear, flight control surfaces and related points of attachment. The actuating portions of items such as landing gear, flight controls, doors, etc. will be treated as systems components and will be analyzed as described in Section 2.3. Attachment of the actuators to the airframe will be treated as structure.

2.4.2.1 Significant and Other Structure

Structure can be subdivided into items according to the consequences of their failure to aircraft safety as follows:

a. A Structural Significant Item (SSI) is any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure or control loads, and whose failure could affect the structural integrity necessary for the safety of the aircraft.

b. Other Structure is that which is judged not to be a Structural Significant Item. It is defined both externally and internally within zonal boundaries.

2.4.3 Damage Sources and Inspection Requirements

This section describes the damage sources and inspection requirements to be considered when developing the structural maintenance program.

2.4.3.1 Damage Sources

The assessment of structure for the selection of maintenance tasks should consider the following damage sources:

a. Accidental Damage (AD), which is characterized by the occurrence of a random discrete event which may reduce the inherent level of residual strength. Sources of such damage include ground and cargo handling equipment, foreign objects, erosion from rain, hail, lightning, runway debris, spillage, freezing, thawing, etc., and those resulting from human error during aircraft manufacture, operation or maintenance that are not included in other damage sources.

   The same sources of accidental damage as those considered for metallic materials are to be considered for non-metallic material such as composites. The consequence of a damage may not be readily apparent and may include internal damage, e.g., disbonding or delamination.

   Large size accidental damage, such as that caused by engine disintegration, bird strike or major collision with ground equipment, will be readily detectable and no maintenance task assessment is required.

b. Environmental Deterioration (ED), which is characterized by structural deterioration as a result of a chemical interaction with its climate or environment. Assessments are required to cover corrosion, including stress corrosion, and deterioration of non-metallic materials. Corrosion may or may not be time/usage dependent. For example, deterioration resulting from a breakdown in surface protection is more probable as the calendar age increases; conversely, corrosion due to galley spillage is a randomly occurring discrete event.

   Stress corrosion cracking in a given environment is directly dependent upon the level of sustained tensile stress which may result from heat treatment, forming, fit-up, or misalignment.

   In contrast to the environmental deterioration process of metallic structures, non-metallic structures such as composites are not normally susceptible to degradation due to the environment. However, the effect of long-term aging in an operating environment has to be taken into consideration when developing the structural maintenance program.

c. Fatigue Damage (FD) which is characterized by the initiation of a crack or cracks due to cyclic loading and subsequent propagation. It is a cumulative process with respect to aircraft usage (flight cycles or flight hours).

2.4.3.2 Inspection Requirements

Inspection requirements in relation to the damage sources are as follows:

a. Accidental Damage (AD), stress corrosion and most other forms of corrosion are random in nature and can occur any time during the aircraft service life. In such cases, inspection requirements apply to all aircraft in the fleet throughout their operational lives.

b. Most forms of corrosion are time/usage dependent and more likely to occur as the fleet ages. In such cases, operator and manufacturer experience on similar structure can be used to establish appropriate maintenance tasks (including CPCP tasks) for the control of environmental deterioration.

2.4.3.2 Inspection Requirements (cont'd.)

The deterioration of non-metallic structures such as composites has to be taken into consideration when establishing maintenance tasks. Appropriate inspection levels and frequencies should be based on existing relevant service experience and manufacturer's recommendations.

c. Detectable size fatigue cracking is not normally anticipated in primary airframe structure until the fleet has matured. Thereafter, structural maintenance programs may require revision.

   For most transport aircraft structure, aircraft with the highest number of flight cycles are more susceptible to initial fatigue cracking in the fleet and are suitable candidates for a fatigue related sampling inspection program, should this be applicable and effective.

2.4.4 Structural Maintenance Program Development

The structural maintenance program is based on an assessment of structural design information, fatigue and damage tolerance evaluations, service experience with similar structure and pertinent test results.

The assessment of structure for selection of maintenance tasks should include the following:

a. The sources of structural deterioration:

   1) Accidental Damage
   2) Environmental Deterioration
   3) Fatigue Damage

b. The susceptibility of the structure to each source of deterioration.

c. The consequences of structural deterioration to continuing airworthiness

   1) Effect on aircraft (e.g. loss of function or reduction of residual strength).
   2) Multiple site or multiple element fatigue damage.
   3) The effect on aircraft flight or response characteristics caused by the interaction of structural damage or failure with systems or powerplant items.
   4) Inflight loss of structural items.

d. The applicability and effectiveness of various methods of preventing, controlling or detecting structural deterioration, taking into account inspection thresholds and repeat intervals.

2.4.4.1 Procedure

The procedure for developing a structural maintenance program is shown in the logic diagram (see Figure 2) and described by a series of process steps (P1, P2, P3, etc.) and decision steps (D1, D2, D3, etc.) as follows:

a. The structural maintenance program includes all aircraft structure which is divided into zones or areas (P1) and structural items (P2) by the manufacturer.

b. The manufacturer categorizes each item (D1) as structurally significant (SSI) (P3) or Other Structure (P4), on the basis of the consequences to aircraft safety of item failure or malfunction.

c. The same procedure is repeated until all structural items have been categorized.

2.4.4.1 Procedure (cont'd.)

d. Items categorized as Other Structure (P4) are compared to similar items on existing aircraft (d2). Maintenance recommendations are developed by the Structures Working Group (SWG) for items which are similar and by the manufacturer for those which are not, e. g., new materials or design concepts (P5). All tasks selected by the SWG (P6) are included in the structural maintenance program (P15).

e. Inspection requirements for timely detection of Accidental Damage (AD) and Environmental Deterioration (ED) are determined for all SSIs (P7). These can be determined for individual SSIs or groups of SSIs which are suitable for comparative assessments on the basis of their location, boundaries, inspection access, analysis breakdown, etc. The manufacturer's rating systems (see 2.4.5) are used to determine these requirements.

f. The process (P7) is repeated until all SSIs are examined.

g. For each SSI, the maintenance requirements are determined (P8) such that the program expectations of the CPCP (2.4.1.5) are fulfilled.

h. The inspection requirement of the ED analysis is compared with the requirement of the CPCP (D9). If they are similar or identical, the ED task will cover the CPCP requirement. If the CPCP task requirement is not met, the ED task has to be reviewed and/or additional and separate CPCP tasks have to be determined (P9).

i. The process (P7, P8, D9) is repeated until all SSIs are examined.

j. All tasks, selected by the SWG, are included in the structural maintenance program (P15).

k. The manufacturer categorizes each SSI as damage tolerant or safe-life (D3).

l. For each item categorized as safe-life (P10), the manufacturer determines the safe-life limit which is included in the aircraft Airworthiness Limitations (P14). No fatigue related inspection program is required to assure continuing airworthiness.

m. All remaining SSIs are damage tolerant (P11) and the manufacturer determines if timely detection of fatigue damage is dependent on scheduled inspections. A scheduled fatigue related inspection program may not be required for SSIs designed to carry the required load with damage that will be readily detectable during routine operation of the aircraft or indicated by safe malfunction (D4).

n. Visual inspections during appropriate scheduled maintenance checks are used, where applicable and effective, to provide the necessary fatigue damage detection opportunities (D5).

o. Applicable nondestructive inspection (NDI) methods, during appropriate scheduled maintenance checks, are used to provide necessary fatigue damage detection opportunities when visual inspections are inadequate (D6).

p. Details of the fatigue related inspection requirements are presented to the SWG who determine if they are feasible (D7). Improved inspection access and/or redesign of the SSI may be required if no practical and effective visual and/or nondestructive inspections are available (D8,P12). If this is not feasible for the manufacturer, the SSI must be categorized as safe-life (P10).

q. Fatigue related inspection requirements selected by the SWG are included in the preliminary Structural Maintenance Program (P15).

2.4.4.1 Procedure (cont'd.)

r. To support Type Certification, selected SSIs (P13, P14) that will eventually be included in the fatigue related inspection program should be listed in the Airworthiness Limitations document.

s. The FD analysis procedure is repeated for all damage tolerant SSIs.

t. Tasks from AD, ED, FD, and other structure analyses are listed in the Structural Maintenance Program (P15).

u. The resulting maintenance requirements for all structure are submitted to the ISC for approval and inclusion in the MRB report proposal.

v. The structural maintenance portion of the Airworthiness Limitations should be included in a separate document and submitted to the appropriate Regulatory Authority (certification) for approval.

FIGURE 2: STRUCTURAL LOGIC DIAGRAM

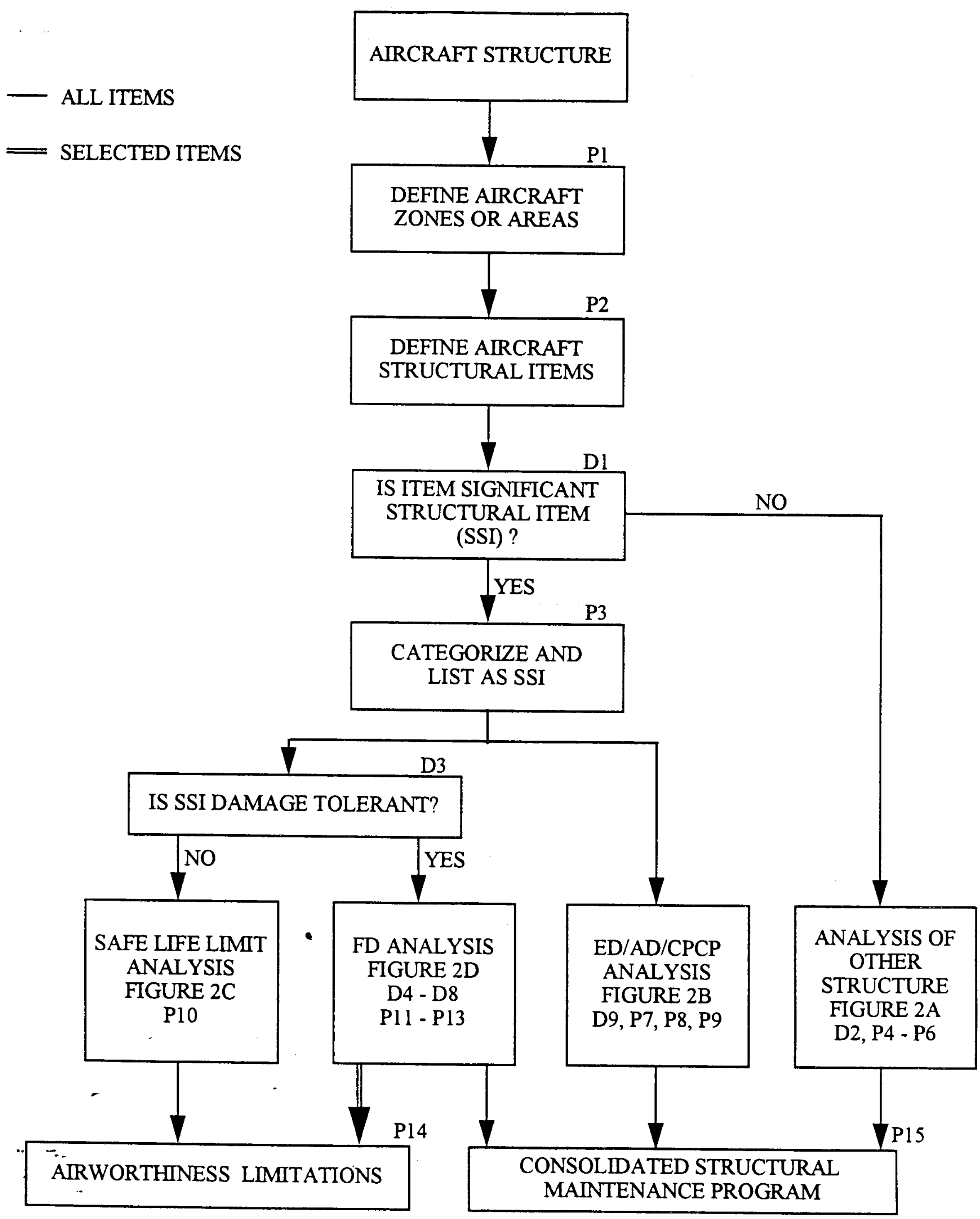


FIGURE 2A: OTHER STRUCTURE LOGIC DIAGRAM

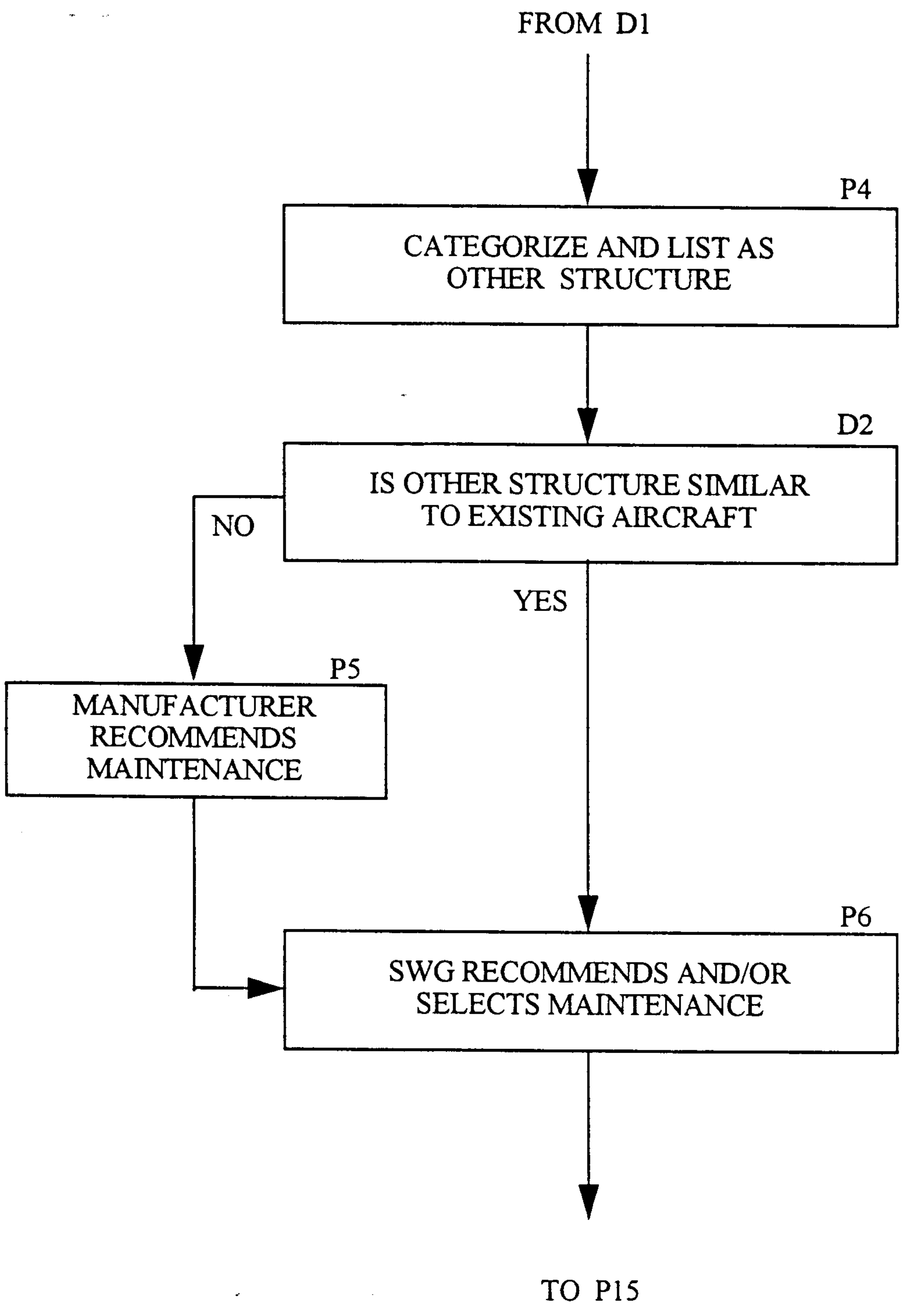


FIGURE 2B:
ACCIDENTAL DAMAGE and ENVIRONMENTAL DETERIORATION
LOGIC DIAGRAM

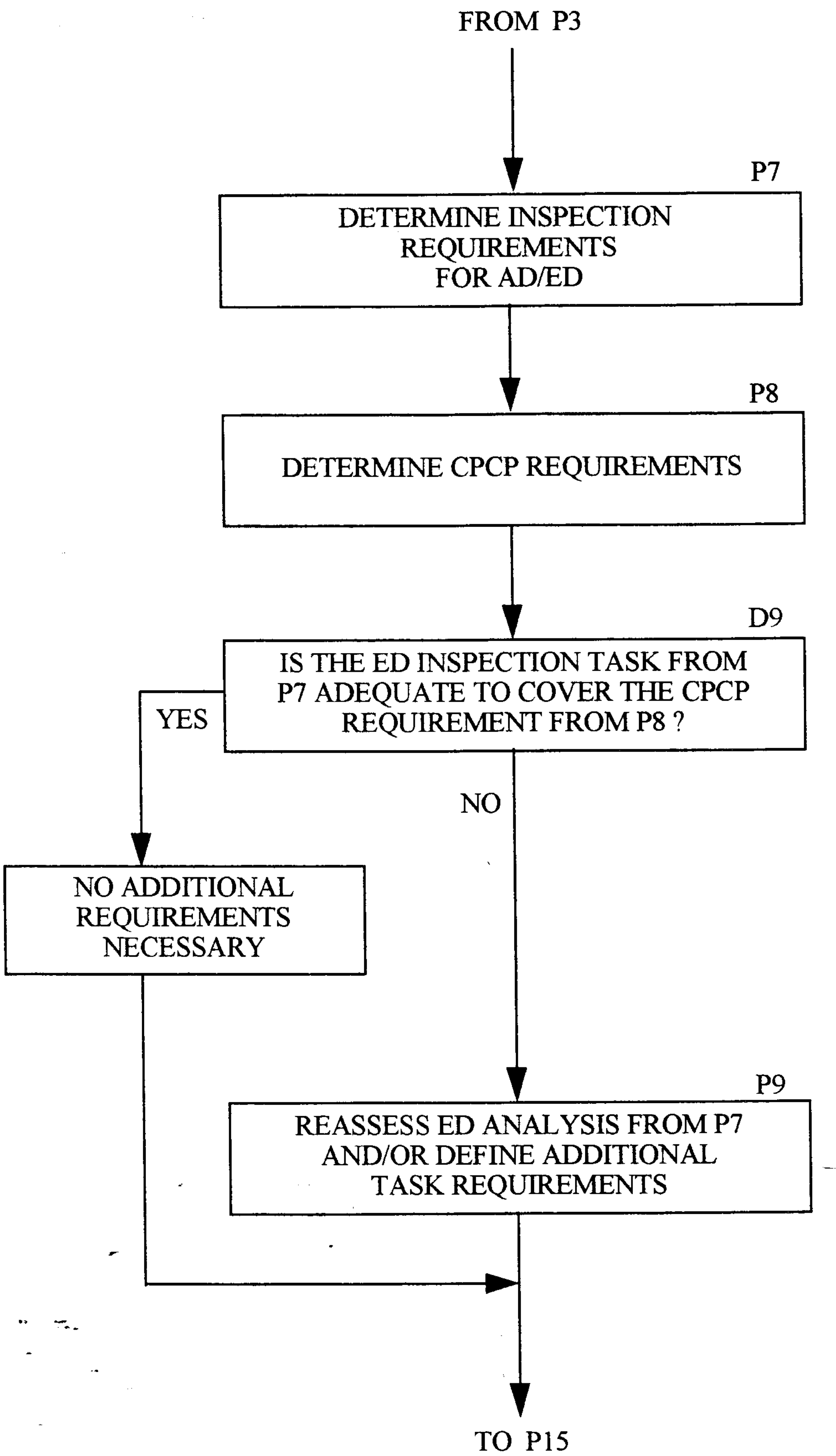


FIGURE 2C: SAFELIFE LIMIT ANALYSIS LOGIC DIAGRAM

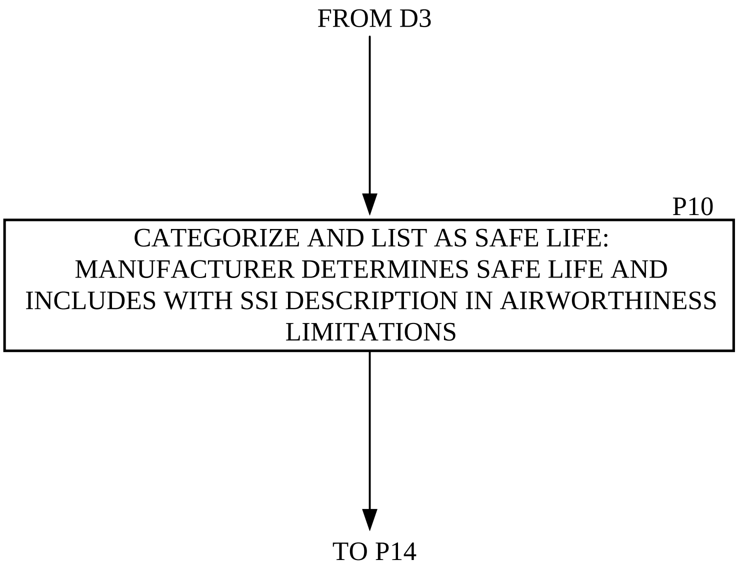
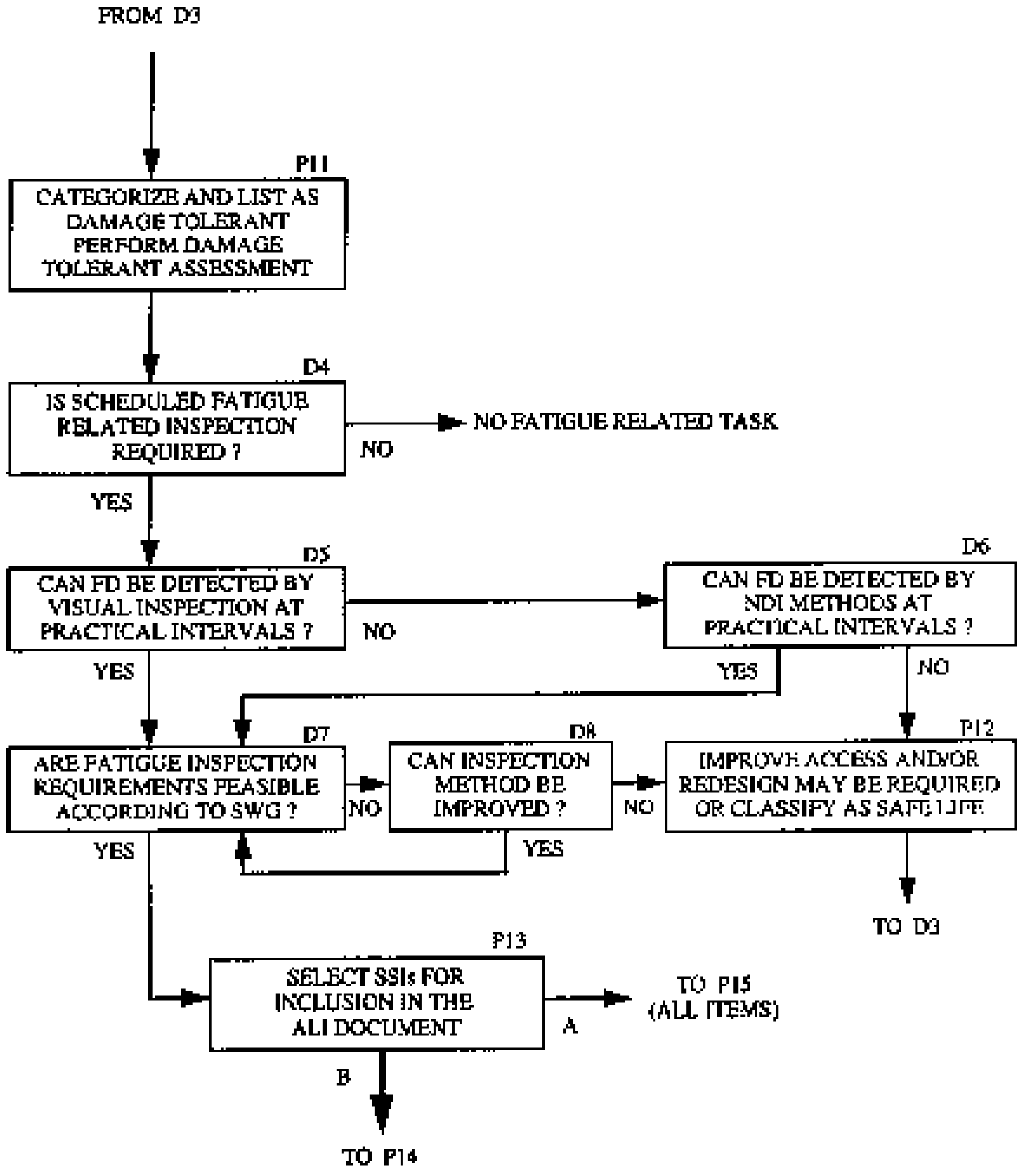


FIGURE 2D: FD ANALYSIS LOGIC DIAGRAM



2.4.5 Rating Systems for Structural Significant Items

As part of the structural maintenance program development, it is necessary to rate each Structural Significant Item in terms of susceptibility (likelihood of damage) and detectability (timely detection of damage). This section provides guidelines to assist manufacturers in the development of suitable rating systems. The rating system should account for the susceptibility of the SSI to the likely source of damage and the likely type of deterioration of the SSI due to the damage source. Differences between metallic and non-metallic portions of the SSI's must be taken into account.

The structural maintenance program is developed on the basis of requirements to assure timely detection of Accidental Damage, Environmental Deterioration, and Fatigue Damage. Rating systems for AD and ED should be compatible to allow comparative assessments for each group of SSIs. Emphasis is placed on rating each SSI in relation to other SSIs in the same inspection area, leading to increased inspection emphasis for the most critical SSIs. Manufacturer and operator experience is a key ingredient for these evaluations.

Rating systems for FD should incorporate results from the manufacturer's residual strength and crack growth evaluations. The applicability and effectiveness of various inspection methods, detectable damage sizes and access requirements are key ingredients for these evaluations.

2.4.5.1 Rating Accidental Damage

Accidental damage rating systems should include evaluations of the following:

a. Susceptibility to minor (not obvious) accidental damage based on frequency of exposure to and the location of damage from one or more sources, including:

    1) Ground handling equipment

    2) Cargo handling equipment

    3) Those resulting from human error during manufacture, maintenance, and/or operation of the aircraft, that are not included in other damage sources.

    4) Rain, hail, etc.

    5) Runway debris

    6) Lightning strike

    7) Water entrapment

b. Residual strength after accidental damage, normally based on the likely size of damage relative to the critical damage size for the SSI.

c. Timely detection of damage, based on the relative rate of growth after damage is sustained and visibility of the SSI for inspection. Assessments should take into account damage growth associated with non-chemical interaction with an environment, such as disbond or delamination growth associated with a freeze/thaw cycle.

Rating values should be assigned to groups of SSIs in the same inspection area on the basis of comparative assessments within the group.

2.4.5.2 Rating Environmental Deterioration

Environmental deterioration rating systems should allow for evaluations of susceptibility to and timely detection of corrosion and stress corrosion.

Susceptibility to corrosion is assessed on the basis of probable exposure to an adverse environment and adequacy of the protective system. For example:

a. Exposure to a deteriorating environment such as cabin condensation, galley spillage, toilet spillage, cleaning fluids, etc.

b. Contact between dissimilar materials (potential for galvanic activity).

c. Breakdown of surface protection systems; for example, deterioration of paint, primer, bonding, sealant, corrosion inhibiting compounds and cladding systems with the resulting corrosion of metallic materials or fluid incursion into permeable non-metallic materials, etc.

Material characteristics, coupled with the likelihood of sustained tensile stress, are used to assess susceptibility to stress corrosion.

Timely detection is determined by sensitivity to relative size of damage and visibility of the SSI for inspection.

Note: Rating system evaluations should be made taking into account the requirement for each operator to control the aircraft structure at corrosion Level 1 or better.

2.4.5.3 Rating Fatigue Damage

The rating system must lead to an inspection program that provides a high probability of detecting fatigue damage in the fleet before such damage reduces any aircraft's residual strength below allowable levels. To achieve this, the rating system should consider the following:

a. Residual strength, including the effects of multiple site fatigue damage, where appropriate.

b. Crack growth rate, including effects of multiple site or multiple element fatigue damage, where appropriate.

c. Damage detection period which corresponds to the interval for the fatigue damage to grow from the threshold of detection (detectable) to the limiting size defined by "a" (critical). This period will vary according to the inspection method used, and may be influenced by structural parts or processes, e.g., sealant obscuring parts of the damage.

d. Detection standards for applicable inspection methods.

   Note: Estimated detectable crack lengths can be used for the fatigue damage detection evaluations required as part of aircraft type certification.

e. Applicable inspection levels and methods (e.g., visual, NDI), directions (e.g., external, internal) and repeat intervals (e.g., C, 2C, 4C).

2.5 ZONAL INSPECTION PROGRAM

The zonal inspection program requires a summary review of each zone on the aircraft. This normally occurs as the MSG-3 analyses of structures, systems, and powerplants are being concluded.

In top down analyses conducted under MSG-3, many support items such as plumbing, ducting, Other Structure, wiring, etc., may be evaluated for possible contribution to functional failure. In cases where a general visual inspection is required to assess degradation, the zonal inspection program is an appropriate method.

2.5.1 Procedure

The following procedures may be used to develop a zonal inspection program:

a. Divide the aircraft externally and internally into zones as defined in ATA specification 100.

b. Prepare a task listing work sheet for each zone including location, description, access notes, etc.

c. During analyses of systems, powerplants and structures, list any general visual inspections which could be conducted as part of the zonal inspection program.

d. Include the interval from the original analyses on the zone work sheet.

e. As the analysis covering items in a zone are completed, the zone should be reviewed to consolidate inspection requirements and assign accomplishment intervals. Document in the work sheets any System/Powerplant or Structural general visual inspections replaced by the zonal inspection task.

2.5.2 Zonal Task Intervals

Accomplishment intervals are based on hardware susceptibility to damage, the amount of activity in the zone, and operator and manufacturer experience with similar systems, powerplants and structures. When possible, intervals should correspond to those selected for targeted scheduled maintenance checks.

GLOSSARY - APPENDIX A

ACCIDENTAL DAMAGE (AD):

Physical deterioration of an item caused by contact or impact with an object or influence which is not a part of the aircraft, or by human error during manufacturing, operation of the aircraft, or maintenance practices.

AGE EXPLORATION:

A systematic evaluation of an item based on analysis of collected information from in-service experience. It verifies the item's resistance to a deterioration process with respect to increasing age.

AIRWORTHINESS LIMITATIONS:

A section of the Instructions for Continued Airworthiness that contains each mandatory replacement time, structural inspection interval, and related structural inspection task. This section may also be used to define a threshold for the fatigue related inspections and the need to control corrosion to Level 1 or better. The information contained in the Airworthiness Limitations section may be changed to reflect service and/or test experience or new analysis methods.

CORROSION LEVEL 1:

Corrosion damage that does not require structural reinforcement or replacement.

or

Corrosion occurring between successive inspections exceeds allowable limit but is local and can be attributed to an event not typical of operator usage of other aircraft in the same fleet (*e.g.* Mercury spill).

CORROSION PREVENTION AND CONTROL PROGRAM (CPCP):

A program of maintenance tasks implemented at a threshold designed to control an aircraft structure to Corrosion Level 1 or better.

DAMAGE TOLERANT:

A qualification standard for aircraft structure. An item is judged to be damage tolerant if it can sustain damage and the remaining structure can withstand reasonable loads without structural failure or excessive structural deformation until the damage is detected.

DELAMINATION/DISBOND:

Structural separation or cracking that occurs at or in the bond plane of a structural element, within a structural assembly, caused by in service accidental damage, environmental effects and/or cyclic loading.

DISCARD:

The removal from service of an item at a specified life limit.

DIRECT ADVERSE EFFECT ON OPERATING SAFETY:

Direct:

To be direct, the functional failure or resulting secondary damage must achieve its effect by itself, not in combination with other functional failures (no redundancy exists and it is a primary dispatch item).

Adverse Effect on Safety:

This implies that the consequences are extremely serious or possibly catastrophic and might cause the loss of aircraft or injury to occupants.

Operating:

This is defined as the time interval during which passengers and crew are on board for the purpose of flight.

ECONOMIC EFFECTS:

Failure effects which do not prevent aircraft operation, but are economically undesirable due to added labor an material cost for aircraft or shop repair.

ENVIRONMENTAL DETERIORATION (ED):

Physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment.

FAILURE:

The inability of an item to perform within previously specified limits.

FAILURE CAUSE:

Why the functional failure occurs.

FAILURE EFFECT:

What is the result of a functional failure.

FATIGUE DAMAGE (FD):

The initiation of a crack or cracks due to cyclic loading an subsequent propagation.

FATIGUE RELATED SAMPLING INSPECTION PROGRAM:

Inspections on specific aircraft selected from those which have the highest operating age/usage in order to identify the first evidence of deterioration in their condition caused by fatigue damage.

FUNCTION:

The normal characteristic actions of an item.

FUNCTIONAL CHECK:

A quantitative check to determine if one or more functions of an item performs within specified limits.

FUNCTIONAL FAILURE:

How an item failed to perform its function.

HIDDEN FUNCTION:

1. A function which is normally active and whose cessation will not be evident to the operating crew during performance of normal duties.

2. A function which is normally inactive and whose readiness to perform, prior to it being needed, will not be evident to the operating crew during performance of normal duties.

INHERENT LEVEL OF RELIABILITY AND SAFETY:

That level which is built into the unit and, therefore, inherent in its design. This is the highest level or reliability and safety that can be expected from a unit, system, or aircraft if it receives effective maintenance. To achieve higher levels of reliability generally requires modification or redesign.

INSPECTION - DETAILED:

An intensive visual examination of a specific structural area, system, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate by the inspector. Inspection aids such as mirrors, magnifying lenses, etc. may be used. Surface cleaning and elaborate access procedures may be required.

INSPECTION - GENERAL VISUAL (SURVEILLANCE):

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or drop-light and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

INSPECTION - SPECIAL DETAILED:

An intensive examination of a specific item(s), installation, or assembly to detect damage, failure or irregularity. The examination is likely to make extensive use of specialized Inspection Techniques and/or equipment. Intricate cleaning and substantial access or disassembly procedure may be required.

INSPECTION - ZONAL:

A general visual inspection of each aircraft zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.

ITEM:

Any level of hardware assembly (*i.e.*, system, sub-system, module, accessory, component, unit, part, etc.).

LUBRICATION AND SERVICING:

Any act of lubricating or servicing for the purpose of maintaining inherent design capabilities.

MAINTENANCE SIGNIFICANT ITEM - (MSI):

Items identified by the manufacturer whose failure:

a. could affect safety (on ground or in flight), and/or
b. is undetectable during operations, and/or
c. could have significant operational impact, and/or
d. could have significant economic impact

MULTIPLE ELEMENT FATIGUE DAMAGE:

The simultaneous cracking of multiple load path discrete elements working at similar stress levels.

MULTIPLE SITE FATIGUE DAMAGE:

The presence of a number of adjacent, small cracks that might coalesce to form a single long crack.

NON-METALLICS:

Any structural material made from fibrous or laminated components bonded together by a medium. Materials such as graphite epoxy, boron epoxy, fiber glass, kevlar epoxy, acrylics and the like are non-metallics. Non-metallics include adhesives used to join other metallic or non-metallic structural materials.

OPERATING CREW NORMAL DUTIES:

Operating Crew Qualified cockpit and cabin attendant personnel who are on duty.

Normal Duties Those duties associated with the routine operation of the aircraft, on a daily basis, to include the following:

a. Procedures and checks performed during aircraft operation;

b. Recognition of abnormalities or failures by the operating crew through the use of normal physical senses (*e.g.,* odor, noise, vibration, temperature, visual observation of damage or failure, changes in physical input force requirements, etc.).

OPERATIONAL CHECK:

An operational check is a task to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.

OPERATIONAL EFFECTS:

Failure effects which interfere with the completion of the aircraft mission. These failures cause delays, cancellations, ground or flight interruptions, high drag coefficients, altitude restrictions, etc.

OTHER STRUCTURE:

Structure which is judged not to be a Structural Significant Item.
“Other Structure” is defined both externally and internally within zonal boundaries.

REPEAT INTERVAL:

The interval expressed in flight cycles, flight hours and/or calendar time, between successive accomplishments of a specific maintenance task.

RESIDUAL STRENGTH:

The strength of a damaged structure.

RESTORATION:

That work necessary to return the item to a specific standard. Restoration may vary from cleaning or replacement of single parts up to a complete overhaul.

SAFE LIFE STRUCTURE:

Structure which is not practical to design or qualify as damage tolerant. Its reliability is protected by discard limits which remove items from service before fatigue cracking is expected.

SCHEDULED MAINTENANCE CHECK:

Any of the maintenance opportunities which are prepackaged and are accomplished on a regular basis.

STRUCTURAL SIGNIFICANT ITEM - (SSI):

Any detail, element or assembly, which contributes significantly to carrying flight, ground, pressure or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.

STRUCTURAL ASSEMBLY:

One or more structural elements which together provide a basic structural function.

STRUCTURAL DETAIL:

The lowest functional level in an aircraft structure. A discrete region or area of a structural element, or a boundary intersection of two or more elements.

STRUCTURAL ELEMENT:

Two or more structural details which together form an identified manufacturer's assembly part.

STRUCTURAL FUNCTION:

The mode of action of aircraft structure. It includes acceptance and transfer of specified loads in items (details/elements/assemblies) and provides consistently adequate aircraft response and flight characteristics.

TASKS - MAINTENANCE:

An action or set of actions required to achieve a desired outcome which restores an item to or maintains an item in serviceable condition, including inspection and determination of condition.

THRESHOLD:

The initial accomplishment of a specific maintenance task expressed in flight cycle, flight hours, and/or calendar time.

VISUAL CHECK:

A visual check is an observation to determine that an item is fulfilling its intended purpose. Does not require quantitative tolerances. This is a failure finding task.